

Nucleus Solutions for the OMAP Architecture

A White Paper

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The OMAP architecture from Texas Instruments leads the way toward a dual-core computing paradigm for a world of ubiquitous information. The combination of a DSP and RISC unit on one chip provides a basis for the development of all kinds of devices that need to process digital signals while they run conventional code in parallel, especially when power is limited. Next-generation handsets are a convenient example of this approach, where a DSP handles the repetitive processing demands of voice and media streams while control and conventional application code runs concurrently on the RISC core. But the usefulness of the multi-core, system-on-a-chip idea goes much further.

The Dual-Core Paradigm

Increasingly, the appeal of a device relies on the signals it can encode, decode and manipulate. The signal might be a representation of the physical world – voice, music and video to be sure, but also magnetic resonance images, sonar or seismic data – or it might be any kind of data stream traveling through the air or over the wire. Whatever meaning it carries, if it's a high-bandwidth digital signal and it requires processing in real time, a DSP is the best kind of processor for the job. On the other hand, a DSP is unsuitable for control and generic applications, especially if it is spending most of its time performing signal-processing tasks. Adding a RISC core to the system allows general-purpose computing to be done in parallel with signal processing.

Some applications will add more RISC and DSP cores to the mix, but the dual-core configuration is simple and powerful enough to serve as a design pattern that can be applied to old and new problems to develop innovative products. Moreover, because this way of thinking is so widely useful, silicon can be found for low cost.

Nucleus for OMAP

The OMAP architecture gives focus to power efficiency and performance by placing an ARM processor alongside a low-power DSP on a single chip with shared memory and numerous peripherals. The idea is to partition tasks between the two cores in such a way that each one carries out the operations that it performs most efficiently. In this environment, the choice of an RTOS takes on critical importance. You need a multitasking kernel that supports both cores with low interrupt latency and a scalable memory footprint. In addition, you need one that provides an efficient way for the two cores to communicate with each other. Furthermore, the selection of middleware available for the RTOS you choose can be a key factor in the crucial time-to-market equation.

Nucleus RTOS software from Accelerated Technology gives you everything you need to develop sophisticated applications on the OMAP architecture. Nucleus for ARM, Nucleus for DSP, and Nucleus IPC products continue to support new OMAP variants. Nucleus middleware packages are available to meet your laundry list of file system, graphics, networking and connectivity needs, to name only the most immediately relevant. And, as always, Nucleus embedded software is royalty free and delivered with source code.

Figure 1 shows the Nucleus system architecture.

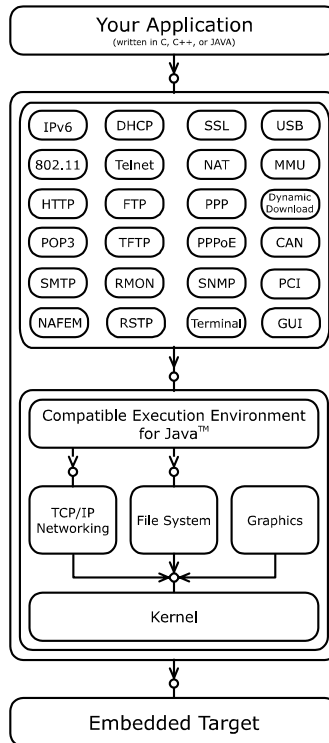


Figure 1: Nucleus system architecture

Nucleus PLUS

Nucleus PLUS is a fully preemptive and scalable kernel suitable for hard real-time applications. The kernel itself can be as small as 15-20 KB. It provides an extensive set of services to manage multiple tasks, inter-task communication and synchronization, events, memory, timers, hardware interrupts and software signals. All kernel functions are provided as libraries, so only the required kernel functionality is linked with the application code in the final image. Figure 2 illustrates the Nucleus PLUS kernel architecture.

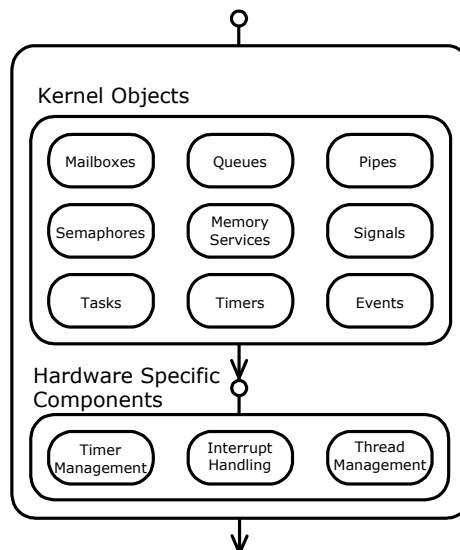


Figure 2: Nucleus PLUS kernel architecture

On an OMAP chip, one Nucleus PLUS kernel runs on each core. Nucleus IPC provides a socket-like shared memory link between the two kernels.

Nucleus Middleware

Adopting the Nucleus PLUS kernel makes an extensive catalogue of middleware available to your system, all of it designed for embedded applications from the ground up. Table 1 gives a snapshot of Nucleus middleware offerings. We'll only look at a few of these products here, but the potential of heterogeneous multi-core computing is great enough that any of them might find their way into an OMAP-based design.

Nucleus Product	Function
Nucleus NET	Complete embedded TCP/IP stack
Nucleus Extended Protocols	Telnet, FTP, TFTP, Embedded Shell
Nucleus SNMP version 1,2,3	Network management protocols
Nucleus RMON (1-9 groups)	Network remote monitoring protocols
Nucleus Residential Gateway	NET, PPP, PPPoE, DHCP server
Nucleus WebServ	Embedded HTTPD Web server
Nucleus EMAIL	POP3 and SMTP
Nucleus FILE	MS-DOS compatible file system
Nucleus GRAFIX	Graphics-rendering engine with windowing toolkit
Nucleus USB	Complete USB stack for USB specifications 1.1, 2.0, and OTG
Nucleus 802.11 STA (WiFi)	802.11b and 802.11g protocol stack
Nucleus IPv6	IP version 6 protocol stack
CEE-J Java VM for Nucleus	CLDC, MIDP, Embedded Java and Personal Java

Table 1: Nucleus Middleware

Nucleus NET

Nucleus NET, our fast and compact TCP/IP networking stack, enables your embedded application to communicate with other hosts on the Internet. The Nucleus NET sockets API allows anyone familiar with Berkeley-style sockets to jump right into embedded networking. To get you started even more quickly, demonstration applications are included to illustrate how to create basic network clients and servers.

The protocols provided with Nucleus NET are TCP, UDP, IP, ICMP, IGMP, ARP, RARP, BOOTP Client, DNS Resolver, DHCP Client, RIP/RIP II and TFTP Client.

Nucleus FILE

Nucleus FILE provides all the necessary functions to manage MS-DOS compatible disks. This embedded file system is fully reentrant, ROMable and task aware. It services simultaneous requests from multiple tasks for true embedded performance. Nucleus FILE is compatible with FAT12, FAT16 and FAT32 file systems with support for long filenames and partitioned disks. A disk formatting utility and a RAM disk driver are also included in the package.

Standard device drivers are available for floppy disks, IDE/ATA hard drives and SCSI devices. PCMCIA support is also available for IDE/ATA compatible drives.

Nucleus GRAFIX

Nucleus GRAFIX is a full-featured graphics toolkit that encompasses a windowing toolkit for desktop-style GUIs, rendering services for low-level drawing and a device driver that isolates target hardware. For projects that don't require a windowed GUI, the rendering services can be used directly to provide a much smaller memory footprint.

Nucleus GRAFIX rendering services provide a complete set of low-level graphics routines, including off-screen memory bitmaps, keyboard and event services, automatic cursor tracking, user definable bitmap text, scalable vector text, hit detection, rounded-corner rectangles, dynamic font facing, marker plotting, polyfill rules, dash styles, line caps, arbitrary-shape region computation and clipping, variable size fill patterns, enlarged colored cursors, PostScript style drawing pens, international fonts and more.

For windowing toolkit applications, you design your panels visually using Microsoft Visual Studio to produce a resource script that is read and converted to C for ultimate integration into your application. The windowing toolkit provides all the GUI functionality you would expect from a desktop windowing system, including events, windows, dialog boxes, menus, controls, desktops, fonts and context-sensitive help.

Conclusion

Nucleus RTOS software is a great choice for designs based on the OMAP architecture. Using the well-known Nucleus PLUS kernel carries many benefits by itself: field-tested reliability, highly evolved performance and broad feature coverage are all notable advantages. But often the best reason to base your application on a commercial kernel is to gain access to the middleware that has already been developed for it. Nucleus middleware covers a range of application domains as wide and varied as the design opportunities made possible by the OMAP architecture and its dual-core DSP/RISC paradigm. And no matter what combination of kernel software and middleware you choose, Nucleus RTOS users always get software that is informed by the embedded development process, designed for embedded environments and provided with source code, without incurring the ongoing cost of runtime royalties.